for Existence, 1934) who experimentally demonstrated a prineiple long familiar, in effeet, among field naturalists that two speeies with similar ecology eannot eo-exist in the same habitat. In a normal mainland environment a diversity of similar animal spceies ean oeeur, eaeh eharaeteristie of a partieular eeologieal niehe or else differing in food preferenees. A small island, however, cannot maintain a variety of habitats of suffieient effeetive area and there must eome a point in the reduetion of an island, varying for different speeies, where distinetion between eeologieal niehes is no longer a real faetor. The formerly non-eompeting forms are no longer so and Gause's Law eomes into operation. Whieh speeies survives may depend on fine differenees in the reaetions of eaeh to the partieular insular environment, or perhaps, be entirely fortuitous.

David Laek *(Genetics, Paleontology, and Evolution,* 1949, p. 302) has referred to the subjeet in his study of the finehes of the Galapagos, stating: "The reduetion in the number of species and of eeologieal niches, even in the same general type of habitat, on islands as eompared with eontinents, and on small as compared with large islands, seems widespread in birds, and should be studied further." Ernst Mayr *(Advances in Genetics,* vol. 2, 1948, p. 215) quotes Stresemann in pointing out that "there is some eorrelation between the number of eeologieal niches in a given region and the number of sympatrie related speeies that ean be aeeommodated. The poverty of island faunas is partly due to this factor. Spccies whieh on mainlands live side by side may be strietly allopatrie on islands."

Rottnest Island has an area of 4,726 aeres, Garden Island, 2,790 aeres and Carnae Island, 43 acres. These islands appear to have been redueed to an area whieh is signifieant for the limitation of numbers of speeies of moderately-sized vertebrates. For insects and other invertebrates the critieal threshold area may not have been reaehed.

The bevelling out of effective differenees betwecn eeologieal niehes on small islands, and the eonsequent simplification of the ecological pieture, means that only *one* speeies of a group with rather similar habits will, in general, survive. The eonsequent removal of inter-speeifie eompetition may result in the single surviving species oecupying habitats in which it would not normally be found on the mainland. The removal of hrakes to population increases by the elimination of inter-speeifie competition may also result in the individuals oeeurring in mueh greater eoneentration than is ordinarily found on the mainland. There may be a poverty of species on small islands but often the abundanee of individuals is very great. Western Australian examples are striking, namely the Quokka on Rottnest, the lizard *Egernia kingii* on Pelsart and Eelipse Islands, and the Death Adder *(Acanthophis antarcticus)* on some of the Reeherche Islands. In Bass Strait some islands, notably Chappell, carry a population of Tiger Snakes whieh has made them notorious.

BAG SHELTER CATERPILLARS AND THEIR HABITS

By Mrs. M. B. MILLS, Merredin.

To anyone taking a walk in the bush in the Wheatbelt in the early part of the year it will not be an uncommon experience to come on many silken bags hanging from jam or wattle trees. Most people know that these are the constructions of the Processionary or Bag Shelter Caterpillar, but the details of the very interesting life history are little known. There are other similar caterpillars which live in shelters on the ground at the butts of jam and wattle trees. I have reared the larvae of both and have submitted them for identification by the Division of Entomology of the C.S.I.R.O. at Canberra. Mr. I. F. B. Common has replied as follows:—

"The two moths are, as far as I know, the one species, *Ochrogaster contraria* (Walker) (Family Notodontidae). This is an extremely variable species and the specimens forwarded come within the range of variation in the specimens at present included under this name. The species is the well-known bag shelter caterpillar of the inland portion of the Eastern States, and causes damage to numerous native trees including several Acacias, such as boree, brigalow, etc. The larvae usually form a bag shelter by webbing together leaves and twigs of the host tree, within which the larvae live gregariously, emerging from the shelter at night to feed. Sometimes the larvae live gregariously in a webbing shelter against the base of the tree. As far as we know the two kinds of larval behaviour are exhibited by the one species."

Though taxonomists include the two types of caterpillars as one species I have found it possible to distinguish between them and, as the following notes show, though their activities may at times confuse each other, the arboreal types keep separate from the terrestrial ones. In the description of life history behaviour in the following account I have found it convenient to restrict the use of the name "Bag Shelter Caterpillar" to those with shelters in trees whilst those with shelters at the butts of trees are referred to as "Ground-nesting Caterpillars." Some details of the life history of the latter were given by me in the *W.A. Naturalist,* vol. 2, 1950, pp. 84-87. The present contribution deals mainly with "Bag Shelter Caterpillars" proper.

On January 1, 1950, at Merredin, a small, almost round, straw-coloured object was seen on the slender branch of a jam tree. It was soft to the touch. This was the first small beginning of what would later become a large silken bag suspended in the jam tree: the shelter of the Bag Shelter Caterpillar *(Ochrogaster contraria).*

The female moth settles on the branch or at the fork of a tree, usually on a slender twig of a jam or wattle tree and lays her eggs there. The eggs remain on the twig, apparently stuck on with a sticky substance from the moth's body. The eggs are covered with fawn or light coloured fluffy scales from her body. The scales covering the eggs are "packed" into a round shape,

from which, usually after a short period, the eggs hatch and the tiny caterpillars begin their life.

For about 9 days there was no noticeable change, then tiny holes appeared all over the small bag shelter.

On January 10, a hot day with the temperature over 100° F. at 2.15 p.m., a number of small hairy caterpillars about ¼ in. in length and grey-greenish in colour, were moving about on the shelter, with half a dozen in single file proceeding along a jam branch. The caterpillars were not seen out on the following days, until January 17 at 7.30 p.m. when they were found grouped on a leaf feeding. After feeding they proceeded in single file along the branch to their shelter, entering it through the small holes. There were 21 caterpillars in the line. After that they were not seen out for a few days; cast skins were adhering to the bag.

On January 22, at 7.30 p.m., 6 caterpillars were out to feed and returned to the bag. Usually a fine white silken thread is left hanging to the leaf as it is fed on; the caterpillars also leave a fine silken trail on the tree branch leading to and from the bag. That evening was stormy and cool, with light showers; the rain did not disturb the caterpillars.

The following day was very hot. At 7.30 p.m. 26 caterpillars were moving along a branch a short way from the bag, in search of food; they settled on the jam leaves to feed, returning to their shelter 45 minutes later.

The caterpillars were not seen out again for about a week, but some cast skins were showing out of holes in the bag. The largest hole in the bag had been closed with silken threads.

On February 1 many leaves had been eaten from the branch of the tree, skins and "dirt" adhered to the bag; one caterpillar

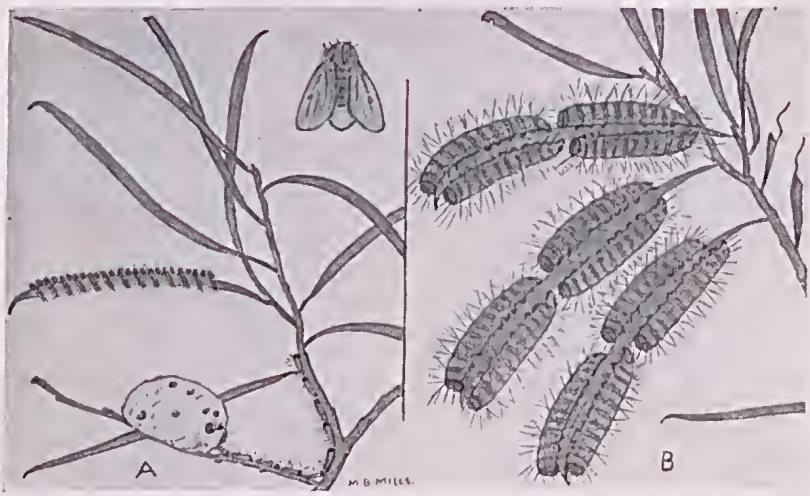

Fig. 1—A—Young caterpillars emerging from the shelter to feed while others rest on either side of a leaf feeding. Female moth at upper left-hand corner. B—Caterpillars feeding. Half natural size.

was seen in a hole in the bag. That evening at 7.30 the caterpillars came out to feed, clustering on the leaves. Ten minutes later they returned to the bag, and on arriving there they crowded on top, in a round, hairy mass, seeking the holes, and one by one disappeared within. In doing so loose cast skins were pushed aside from the holes to blow away in the wind.

The next evening was cool with strong winds. At 7.15 the caterpillars left the bag and set off in single file along the branch to the leaves.

On February 3 at 6.15 p.m. the caterpillars were returning from feeding. They had moved along the branch in the opposite direction seeking a new branch on which to feed, the previous one being almost bare of leaves. When they reached the bag they spent a short time weaving silken threads over and about it, and to the fork of the tree, closing all but two holes in the bag.

February 5.—The caterpillars returned from feeding at 7.30 p.m. They had gone further along the branch in search of a new feeding place.

Next evening they set out to feed at 7 o'clock, returning 45 minutes later. While they were feeding on the leaves, it was interesting to watch three caterpillars at a leaf clinging to a thread, swinging in mid-air several feet above the ground; the thread was an inch long and looped, two caterpillars were upside down, but had a fast grip, the heads and some legs were loose. They moved along the silken thread and on to the leaf.

The next three evenings the caterpillars were not seen out at the usual time; one large hole in the bag was threaded over. The bag was increasing in size, neat and covered with shining silken threads.

On February 10, at 7 p.m., 17 caterpillars emerged to feed, coming out of one hole in the bag. The day had been hot and cloudy with strong winds; at evening it was calmer, but stormy. The caterpillars returned from feeding at 8.15 p.m. Next day there were some cast skins on the bag.

On February 12, at 7.15 p.m., 24 caterpillars were out to feed; half an hour later they returned to the bag. Then for five days the caterpillars were not seen, although each day there were newly-cast skins on the bag.

On the morning of February 18, at 11.45, the caterpillars moved to another branch on the same tree and had made a new bag shelter. Silken threads led from the old bag down the tree branch to the butt, then across a fork, up another branch to near the leaves. There in a fork a slightly larger bag had been made.

Next evening the caterpillars were grouped on leaves feeding above the new bag; they returned to it half an hour later.

All the next week the caterpillars were not seen, but emerged again on February 27 at 6 p.m., and at the same time again next evening, returning over an hour later to the bag. The weather was very hot, over 100° F.

On March 1, at 7.25 p.m. two caterpillars were out of the bag, one was weaving silken threads about the top of it, while the other

eaterpillar was resting a short way up the branch. They remained there for almost an hour. Next evening, at 7 o'clock, a number of eaterpillars were massed on the bag weaving silken threads about it; shortly afterwards they set off to feed, returning at 9 o'clock.

For the following days there was no change in their habits. Then on March 7 and the four following days they were not seen out feeding, but may have come out very early in the morning or late at night, as the branch was becoming bare of leaves. The bag was neat and well threaded over with shining silken threads.

On March 12 the eaterpillars emerged from the bag between 7.15 p.m. and 7.55 p.m. At 7.55 p.m. they were up on the leaves feeding or seeking food. The leaves had been eaten from the branch, leaving almost bare twigs. The eaterpillars moved about quite a lot seeking leaves; one apparently lost the group and returned towards the bag.

Early next morning the eaterpillars left their shelter and proceeded down the branch in single file. They were intercepted by small black ants, which made angry darts at the eaterpillars, halting them for some minutes. When the ants left off attacking them, the eaterpillars moved off again down the branch to another forked branch lower down from the bag. Ants had been swarming on the bag for almost a week.

On March 14, at evening, the eaterpillars were out feeding on a new branch.

There were now many silken trails leading up and down the jam tree, some of them having been made by the Bag Shelter Caterpillars; but a number of the heavier or more clearly defined trails had been made by a nest of hairy eaterpillars described here as Ground-nesting Caterpillars, which hatched out in a light coloured fluffy nest under an upturned sheep trough near the butt of the jam tree. There was a large number of eaterpillars in the nest (195) and as they travelled about the tree to feed, soon left many silken trails.

The trails of the Ground-nesting Caterpillars seemed to confuse the Bag Shelter Caterpillars and as they returned to their shelter, would often take the wrong trail, and spend a while getting back to their bag. One eaterpillar was found apparently lost and almost dead, with ants attacking it, at the butt of the tree.

On March 15 at 7.15 p.m. the Bag Shelter Caterpillars were moving down the branch, which forked at the butt of the tree. They then crossed over, ascending another branch. Two of these, which appeared lost, were found moving along the edge of the upturned sheep trough, under which the Ground-nesting Caterpillars had their nest 18 inches away from the jam tree. The two Bag Shelter Caterpillars may have followed a silken trail down the tree, along the ground and to the Ground-nesting Caterpillars' nest. The two eaterpillars were placed back with the group on the branch.

Early next morning the eaterpillars ascended a branch to the leaves and grouped there; then commenced to weave silken

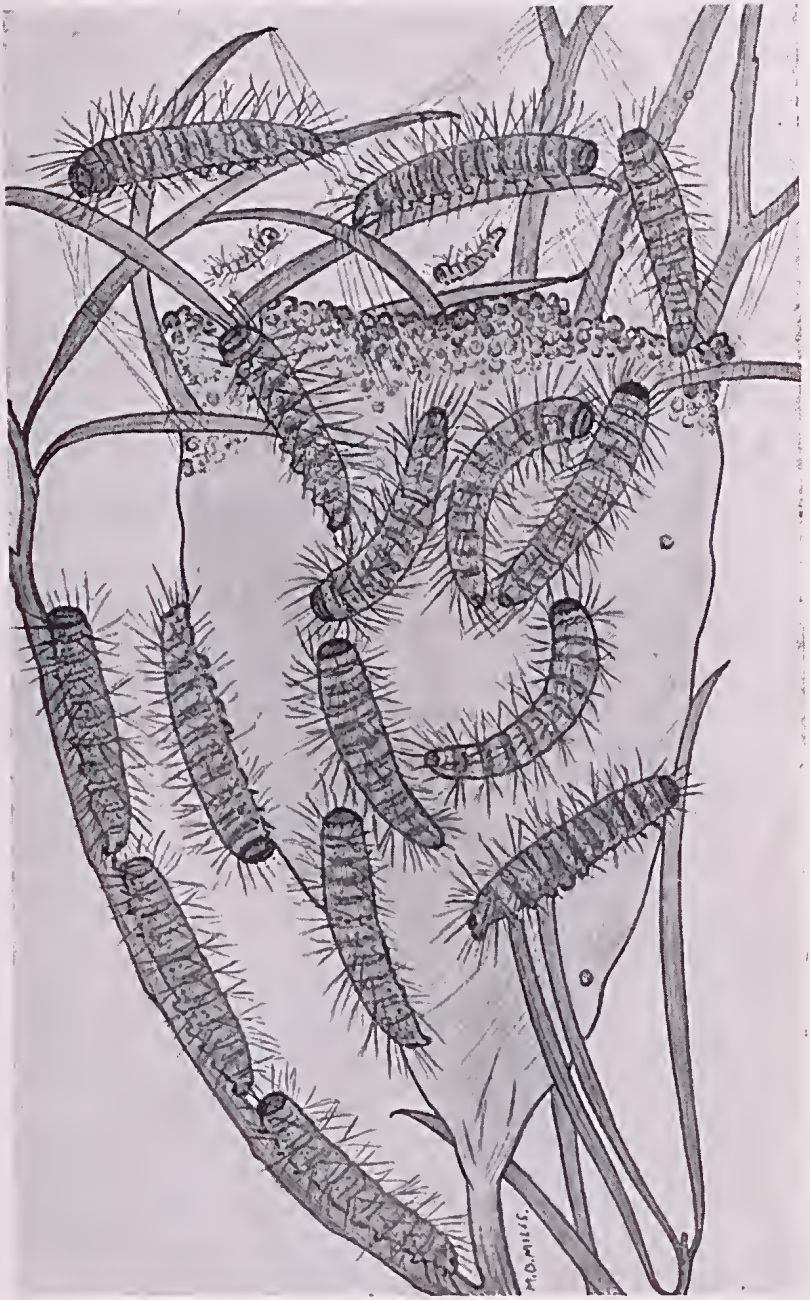

Fig. 2—The silken bag shelter with almost fully grown caterpillars weaving silken threads about the bag; some caterpillars ascending a branch to feed. Nearly natural size.

—Mrs. M. B. Mills del.

threads about a small fork in the branch and to leaves in a eireular manner. Later they moved into the rather frail, transparent new bag shelter.

The following day was spent working on the new bag, the caterpillars' bodies looking like a round fluffy ball as they weaved silken threads. At evening they left the bag to feed on the leaves. For five days they eontinued in this way, setting out eaeh evening, but one, to feed.

Then a week passed and the eaterpillars were not seen out. A search was made about the tree; the new bag slightly opened, but it was empty. The bag from whieh they had previously moved eontained some eaterpillars. Onee again, the many trails leading up and down all the branehes of the tree may have eonfused the eaterpillars, eausing them to lose their trail baek to the new bag, and finally, in a maze of trails had made their way to the other bag.

On Mareh 29 the eaterpillars left the bag to feed. It was found later that they did not return to it; there was no traee of them on their own or at nearby trees. They had eompletely disappeared.

On Mareh 30 a further seareh was made for the missing Bag Shelter Caterpillars, and at evening they were found in the nest of the Ground-nesting Caterpillars near the butt of the tree. At 7.30, as the Ground-nesting Caterpillars emerged from their nest under the sheep trough and began to ascend the tree to feed, a number of Bag Shelter Caterpillars were also travelling along in the proeessionary line in a normal manner.

Although the two lots of eaterpillars elosely resembled eaeh other it was possible to distinguish between them by eolour, size and hair length. The Bag Shelter Caterpillars were rather orange eoloured above and hairy, but the hairs appeared to be shorter and sparser than in the Ground-nesting ones; they were also smaller in size, 1½ in. as against 2 in. and over in the Ground-nesting Caterpillars, whieh were grey in eolour with longer hairs thickly covering their bodies.

As the eaterpillars emerged from the nest under the trough they came in this order: A line in single file of Ground-nesting Caterpillars, then two Bag Shelter Caterpillars, followed by several Ground-nesting ones, with 8 Bag Shelter Caterpillars at the end of the line. After feeding, all returned to the ground nest.

On Mareh 31 at 7.30 p.m. the Ground-nesting Caterpillars emerged from their nest and began to ascend the tree to feed, there was sueh a large number of slow moving caterpillars that it was over an hour before all were elear of the nest and had ascended the tree to the leaves. Some of the Bag Shelter Caterpillars were among the last ones at 9 p.m., 13, in two lots of 5 and 8.

The same thing oeeurred next evening, with a number of Bag Shelter Caterpillars climbing the tree with Ground-nesting ones.